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⑪ A No. 961998

④5 ISSUED Jan. 28, 1975

⑤2 CLASS 400-67  
C.R. CL. 18-167  
400-91

①9 CA

# CANADIAN PATENT

⑤4

EXTRUSION OF POLYOLEFINS WITHOUT GEL STREAK  
FORMATION

⑦0

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Granted to Union Carbide Corporation, New York, New York,  
U.S.A.

②1

APPLICATION No. 092,432

②2

FILED Sep. 4, 1970

③0

PRIORITY DATE Oct. 27, 1969 (869,903) U.S.A.

No. OF CLAIMS 10 - No drawing

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BACKGROUND OF THE INVENTION1. Field of the Invention

The invention relates to the extrusion of polyolefins into film.

2. Description of the Prior Art

Polyolefin materials such as polyethylene have been used for a number of years for the preparation of films by extrusion processes. Because of the fact that the extrusion processes usually involve the use of relatively high extrusion  
10 temperatures and prolonged extrusion times it has been found necessary, in order to prevent undesirable degradation of the polymer during the preparation of the film, to use various anti-oxidants with the polyolefin. When such anti-oxidants are used, however, with the film forming grades of polyolefins in certain types of extrusion equipment, gel streaking has been observed in the products thus formed.

The gel streaks usually appear in the extruded film product after about 30 to 60 minutes. The gel streaks may be described or defined, for the purposes of the present invention,  
20 as surface roughness in the form of V gels, streaks or, in extreme instances, texture completely permeated by streaks.

SUMMARY OF THE INVENTION

Anti-oxidant stabilized polyolefin based film extrusion compounds are protected against gel streak formation during the formation of the film by the use of polyalkylene glycol.

An object of the present invention is to provide extruded film made from polyolefins which is free from gel streaking.

A further object of the present invention is to provide a process whereby anti-oxidant stabilized polyolefin based film forming compositions may be extruded so as to avoid the appearance of gel streaking in the extruded film.

#### DESCRIPTION OF THE PREFERRED EMBODIMENT

It has now been found that extruded film which is free of gel streaking and which is prepared from anti-oxidant stabilized polyolefin based compositions can be readily prepared by incorporating polyalkylene glycol into the composition to be extruded.

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#### Polyalkylene Glycol

The polyalkylene glycol which may be used in the present invention is a solid or liquid material at room temperature having a molecular weight at least 100, and preferably of about 100 to 200,000 or more.

About 0.01 to 0.1, and preferably about 0.02 to 0.05, per cent by weight of the polyalkylene glycol is used based on the weight of the olefin polymer in the extrusion compositions.

The polyalkylene glycol is uniformly dispersed in the polyolefin based extrusion composition. The dispersion can be effected by various dispersion techniques commonly employed by those skilled in the art of preparing extrudable compositions. Such procedures would include dry blending by means of a Henshel\* intensive mixer, a ribbon blender or tumbling; or hot compounding in a Banbury\*, Stewart Bolling\*, or Werner Pfliederer\* compounding extruder, Farell\* continuous mixer, or other similar equipment.

20

The polyalkylene glycols to be used in the present invention include polyethylene glycol and polypropylene glycol.

The polyalkylene glycols can be used individually or in combination thereof. The term polyalkylene glycol includes such materials, as well as the mono-C<sub>1</sub> to C<sub>5</sub> alkyl ethers of such glycols.

#### Olefin Polymers

The extrudable olefin polymers employed in the extrudable compositions of the present invention are normally solid materials, that is, solid at room temperature. Any extrusion grade olefin polymer can be used in the compositions of the present invention. The term "olefin polymer" thus includes homopolymers of the olefins, as well as interpolymers of one or more olefins with each other, and/or up to about 30 weight per cent of one or more monomers which are copolymerizable with such olefins. The olefin polymers would include homopolymers and interpolymers of olefins such as ethylene, propylene, 1-butene, isobutylene, as well as interpolymers of one or more of such olefins and one or more other monomers which are interpolymerizable with such olefins, such as other vinyl compounds, i.e., those having the group  $-C = C -$ . Such other vinyl compounds would include: vinyl aryls such as styrene, *o*-methoxystyrene, *p*-methoxystyrene, *m*-methoxystyrene, *o*-nitrostyrene, *p*-nitrostyrene, *m*-nitrostyrene, *o*-methylstyrene, *p*-methylstyrene, *m*-methylstyrene, *p*-phenylstyrene, *o*-phenylstyrene, *m*-phenylstyrene, vinyl-naphthalene and the like; vinyl and vinylidene halides such as vinyl chloride, vinylidene chloride, vinylidene bromide and the like; vinyl esters such as vinyl acetate, vinyl propionate, vinyl butyrate, vinyl chloroacetate, vinyl chloropropionate, vinyl benzoate, vinyl chlorobenzoate and the like; acrylic and

alpha-alkyl acrylic acids, their alkyl esters, their amides and their nitriles, such as acrylic acid, chloroacrylic acid, methacrylic acid, ethacrylic acid, methyl acrylate, ethyl acrylate, butyl acrylate, n-octyl acrylate, 2-ethylhexyl acrylate, n-decyl acrylate, methyl methacrylate, butyl methacrylate, methyl ethacrylate, ethyl ethacrylate, acrylamide, N-methyl acrylamide, N,N-dimethyl acrylamide, methacrylamide, N-methyl methacrylamide, N,N-di-methyl methacrylamide, acrylonitrile, chloroacrylonitrile, methacrylonitrile, ethacrylonitrile, and

10 the like; alkyl esters of maleic and fumaric acid such as dimethyl maleate, diethyl maleate and the like; vinyl alkyl ethers and ketones such as vinyl methyl ether, vinyl ethyl ether, vinyl isobutyl ether, 2-chloroethyl vinyl ether, methyl vinyl ketone, ethyl vinyl ketone, isobutyl vinyl ketone and the like; also vinyl pyridine, N-vinyl carbazole, N-vinyl pyrrolidine, ethyl methylene malonate and the like.

Preferred copolymers are the ethylene copolymers such as ethylene/ethyl acrylate copolymers, ethylene/vinyl acetate copolymers, ethylene/vinyl chloride copolymers, ethylene/acrylic

20 acid copolymers, and the like.

Also included in the term polymer are blends of one polymer with one or more other polymers. Illustrative of such blends are polyethylene with polypropylene, low-density polyethylene with high-density polyethylene, polyethylene with olefin copolymers such as these indicated above for example, ethylene/acrylic acid copolymers, ethylene/methyl acrylate copolymer, ethylene/ethylacrylate copolymer, ethylene/vinyl acetate copolymer, ethylene/acrylic acid/ethyl acrylate terpolymer, ethylene/acrylic acid/vinyl acetate terpolymer, and the like.

Also included within the term polymer are the metallic salts of those olefin copolymers, or blends thereof, which contain free carboxylic acid groups. Illustrative of such polymers are ethylene/acrylic acid copolymer, ethylene/methacrylic acid, oxidized polyolefins, propylene/acrylic acid copolymer, butene/acrylic acid copolymer and the like.

Illustrative of the metals which can be used to provide the salts of said carboxylic acid polymers are the one, two, and three valence metals, such as sodium, lithium, potassium, calcium, magnesium, aluminum, barium, zinc, zirconium, beryllium, iron, nickel, cobalt, and the like.

The preferred olefin polymers for use in the present invention are homopolymers of ethylene, and the most preferred polymers are those having a melt index of about 0.1 to 20 grams per 10 minutes, a density of about 0.915 to 0.925. Low density ethylene polymer has a density of between approximately 0.915 and 0.925, medium density ethylene polymer has a density of between approximately 0.925 and 0.940, and high density ethylene polymer has a density of between approximately 0.940 and 0.970. Thus, the low density homopolymers of ethylene are the most preferred olefin polymers to be used in the present invention, although the medium and high density polymers may also be used.

The olefin polymers may be used in the form of powders, pellets, granules, or any other form that can be fed to an extruder.

#### The Anti-Oxidants

As noted above, the extrudable compositions of the present invention contain at least one anti-oxidant for the



olefin polymer. These anti-oxidants are present in stabilizingly effective quantities. Such amounts are about 0.005 to 0.1, and preferably about 0.01 to 0.02, per cent by weight, based on the weight of the olefin polymer. The anti-oxidant stabilizers which may be employed in the compositions of the present invention include all those polyolefin anti-oxidants commonly employed in olefin polymer based film extrusion compositions. These materials are such as are capable of providing anti-oxidant protection at processing temperatures of the order of about 275 to 650°F. or  
 10 higher.

Such anti-oxidant stabilizers include amines such as diphenylamine, phenyl- $\alpha$ -naphthylamine, phenyl- $\beta$ -naphthylamine, diphenyl-p-phenylenediamine, N,N'-phenylcyclohexyl-p-phenylenediamine and N,N'-di- $\beta$ -naphthyl-p-phenylenediamine; phenols, such as p-hydroxyphenylcyclohexane, di-p-hydroxyphenylcyclohexane, dicresylolpropane, tertiary butyl para cresol, 2,6-di-tert-butyl-p-cresol, 2,4,6-tri-tert-butylphenol, octadecyl-3-(3,5-di-tert-butyl-4-hydroxyphenyl)propionate, condensation products of dialkylphenols with formaldehyde, reaction products of phenol  
 20 with styrene, 1,1'-methylene-bis-(4-hydroxy-3,5-tert-butylphenol), 2,2'-methylene-bis-(4-methyl-6-tert-butylphenol), 2,6-(2-tert-butyl-4-methyl-6-methylphenol)-p-cresol, phenylethylpyrocatechol, phenylisopropylpyrocatechol, 1,1,3-tris(2'-methyl-5'-t-butyl-4-hydroxy phenyl)butane, 2,2-methylene-bis- $\bar{6}$ -( $\alpha$ -methylcyclohexyl)-4-methylphenol $\bar{7}$ , 1,3,5-trimethyl-2,4,6-tris-(3',5'-di-t-butyl-4-hydroxybenzyl)benzene and  $\alpha$ -naphthol; and sulfur containing compounds such as 2,2'-thio-bis-(4-methyl-6-tert-butylphenol), 4-4'-thio-bis-(3-methyl-6-tert-butylphenol),

thio-bis( $\beta$ -naphthol), thio-bis-(N-phenyl- $\beta$ -naphthylamine), methylthio-2-naphthalene, diphenyl sulfide, diphenyl disulfide, 3-tolyl disulfide, 1-dodecyl disulfide, polymeric 1,10-decanedithiol, 2-toluene thiol, 2-naphthylthiol, mercapto-benzothiazole, 1-dodecyl mercaptan, phenyl benzyl sulfide, 2,2'-tert-butyl-4-methyl phenol sulfide, tetramethylthiurammonium sulfide, tetramethylthiuram disulfide, 2,2'-diphenyldiamine disulfide, 4,4'-diphenyldiamine disulfide, mercaptobenzimidazole, di- $\beta$ -naphthyl sulfide, methyl- $\beta$ -naphthyl sulfide, 2,2'-thio-  
 10 bis-(4-methyl-6-tert-butyl phenol) and dilauryl thiodipropionate; and other compounds such as 2,6-di-tertiary-butyl-4-methylphenyl, esters of pyrocatecholophosphorus acid, tri(mixed mono and dinonyl phenyl)phosphites, phosphites of  $\alpha$ -naphthol and pyrocatechol, and carbon blacks.

The preferred anti-oxidant stabilizers which are employed in the compositions of the present invention are 2,6-ditertiary butyl paracresol, or butylated hydroxy toluene (BHT); butylated hydroxy anisole (BHA); 1,1,3-tris(2-methyl-4-hydroxy-5-tertiarybutyl phenyl) butane (Topanol CA\*); dilauryl thiodi-  
 20 propionate (DLTDP); distearyl thiodipropionate (DSTDP); tri(mixed mono and dinonyl phenyl) phosphite (Polygard\*); or octadecyl-3-(3,5-di-tert-butyl-4-hydroxy phenyl)propionate (Irganox 1076\*).

The anti-oxidants may be used individually or in various combinations with one another in the compositions of the present invention.

#### Extrudable Compositions

The extrudable compositions of the present invention may be used in any of the forms of such compositions which are

\*Trade Mark or Trade Name

commonly employed in the extruded film arts, such as compounds modified with various slip and anti-block additives for specific end use applications.

These extrudable compositions may be thermoplastic or thermosetting in nature. Where they are thermosetting they may contain about 0.001 to 1 per cent by weight, based on the weight of the olefin polymer of a crosslinking agent which is commonly employed to crosslink olefin polymers. Such crosslinking agents would include free-radical generating agents  
 10 such as organic peroxygen compounds such as dicumyl peroxide; tertiarybutyl perbenzoate; 2,5-dimethyl-2,5-di-(tertiary-butyl peroxide)hexane; and 2,5-dimethyl-2,5-di(tertiary butyl peroxy) hexyne; and azo compounds such as 2-phenyl azo-2,4-dimethylvaleronitrile, 2-phenylazoisobutyronitrile; 2-phenyl azo-2,4,4-trimethylvaleronitrile; and 2-phenylazoisobutyramide. In addition to the olefin polymer, anti-oxidant, crosslinking agent, if any, and polyalkylene glycol, the compositions of the present invention may contain other adjuvant materials which are commonly employed in olefin polymer-based extrudable film  
 20 compositions. Such other adjuvants would include plasticizers, fillers, pigments, lubricants, slip agents, modifiers and similar materials.

The fillers which may be used in the olefin polymer-based extrudable compositions of the present invention are the fillers which are commonly used with such polymers. The fillers are used in amounts which correspond to about 1 to 20 per cent by weight, based on the weight of the olefin polymer. Such fillers would include materials such as carbon black, titanium

di xide, clays, diat mace us earth, calcium silicates and others known in the art.

The plasticizers which may be employed in the olefin polymer-based extrudable compositions of the present invention are the plasticizers which are commonly used with such polymers. The plasticizers are used in amounts which would correspond to about 1 to 25 per cent by weight based on the weight of olefin polymer. Such plasticizers would include materials such as phthalates, phosphates, adipates, azelates, amine based polyols, and a number of other similar products.

The lubricants which are commonly employed in the olefin polymer-based extrudable compositions are the lubricants which are commonly used with such polymers. The lubricants are used in amounts which correspond to about 0.02 to 0.2 per cent by weight of lubricant agent based on the weight of the olefin polymer. Examples of such lubricants are fatty acid amides such as stearamide, oleamide, behenamide and erucamide.

#### Extruding Conditions

The extrudable compositions of the present invention are particularly designed for use in equipment utilized for tubular film, cast film and extrusion coating products. Such equipment, when operated at low rates of extrusion, or when it has hold up areas that retard the flow of extrudate therethrough, leads to the development of gel streaking in the absence of the use of the polyalkylene glycol additive of the present invention. In such equipment the polyolefin based extrudable compositions are subjected to extrusion temperatures of about 275 to 650°F., and preferably about 375 to 650°F., under varying conditions

f head pressure, and for periods of time of about 0.5 to 10 minutes.

The film is usually prepared in sheets which are about 0.1 to 10 mils thick.

The following examples are merely illustrative of the present invention and are not intended as a limitation upon the scope thereof. In the Examples that follow the olefin polymers that were employed had the following characteristics

	Polymer	Chemical Composition	Density	M.I. (ASTM-D-1238-62T) grams/10 minutes
10	A.	ethylene homopolymer	0.922	1.5
	B.	ethylene homopolymer	0.922	0.8
	C.	ethylene homopolymer	0.919	3.0
	D.	ethylene homopolymer	0.920	4.0
20	E.	ethylene homopolymer	0.921	12.0
	F.	ethylene homopolymer	0.923	3.0
	G.	ethylene homopolymer	0.923	1.5

#### EXAMPLE 1

A series of experiments were run to demonstrate the need for the use of a polyalkylene glycol in polyolefin based film extrusion compounds in order to prevent the formation of gel streaks in the extruded film.

Five basic formulations were employed using a different polymer in each of the formulations. The base or control formulations used in these Examples are numbered M, N, O, P, and Q, and had the following compositions:

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<u>Base Formulation</u>		M	N	O	P	Q
<u>components (in % by weight)</u>						
10	Polymer A	99.834	-----	-----	-----	-----
	Polymer B	-----	99.82	-----	-----	-----
	Polymer C	-----	-----	98.47	-----	-----
	Polymer D	-----	-----	-----	99.99	-----
	Polymer E	-----	-----	-----	-----	48.745
	Polymer F	-----	-----	-----	-----	49.745
	Superfloss*	0.08	0.1	1.5	-----	-----
	oleamide	0.05	0.05	-----	-----	0.14
	stearamide	0.02	0.02	0.02	-----	0.07
	BHT	0.01	0.01	0.01	0.01	0.02

Superfloss\* is finely divided diatomaceous earth.

Various amounts of polyethylene glycol (PEG) having a molecular weight of about 4000 were also added to various of the test formulations. Where the PEG was added, the amount of polymer present in the base formulation was reduced by the amount of PEG that was added.

The formulations were prepared by homogenously admixing the components thereof in a Banbury for about 4 minutes at a temperature of about 250°F. After the formulations were prepared, films were extruded in a tubular extrusion device for various periods of time to assess gel formation. The extrusion equipment was composed of a 1 1/2 inch, 20:1 length : diameter ratio extruder equipped with a 4-inch deep side fed tubular die. Extruder conditions were the following:

Extruder Barrel

<u>Back</u>	<u>Middle</u>	<u>Front</u>	<u>Gate</u>	<u>Adaptor</u>	<u>Die 1</u>	<u>Die 2</u>
240°F.	325°F.	395°F.	395°F.	450°F.	395°F.	395°F.

Screw speed - 25 revolutions per minute

Take up speed - 20 feet per minute

Layflat width (film) - 9 inches.

\*Trade Mark or Trade Name

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The extruded films were approximately 1.5 mils thick. During extrusion the films were examined periodically for gel streak formation. Table I below discloses the compositions that were employed and the results that were obtained with respect to gel streak formation. In this regard the table specifically discloses the formulation employed; the amount, if any, of PEG admixed with the formulation (in parts per million-ppm); the temperature (in °F.) of the adaptor element of the extrusion device; and the appearance of the film products after various intervals of time following the extrusion of the film. The letter symbols used to designate the visual appearance of the films with respect to gel streaking have the following meanings:

C- clear of gel streaking  
VSL- very slight gel streaking  
SL- slight gel streaking  
M- moderate gel streaking  
Sev- severe gel streaking  
V Sev- very severe gel streaking

20 A review of the information disclosed in Table I shows that the addition of PEG to the base or control formulations completely, or at least substantially, prevents the formation of gel streaking in the extruded films.

TABLE I  
Effect of PEG on Gel Streaking Tendency of Polyethylene Film Compounds

Base Formulation	PEG-4000, ppm	Adaptor, °F.	Film Appearance After Extrusion Time, Minutes									
			5	10	15	20	25	30	40	50	60	120
M	0	450	C	C	C	SL	SL	SL	M	M	M	-
M	100	450	C	C	C	C	C	C	C	C	C	-
M	200	450	C	C	C	C	C	C	C	C	C	-
M	400	450	C	C	C	C	C	C	C	C	C	-
N	0	475	SL	M	M	SL	SL	M	M	M	M	-
N	100	475	C	C	VSL	SL	SL	SL	SL	SL	SL	-
N	200	475	C	C	C	C	C	C	C	C	C	C
O	0	450	SL	Sev	VSev	VSev	-	-	-	-	-	-
O	200	450	C	C	C	SL	SL	SL	SL	SL	SL	-
O	400	450	C	C	C	C	C	C	C	C	C	C
O	700	450	C	C	C	C	C	C	C	C	C	C
O	1000	450	C	C	C	C	C	C	C	C	C	C
P	0	450	M	Sev	VSev	VSev	-	-	-	-	-	-
P	100	450	C	C	C	C	C	C	C	C	C	-
P	200	450	C	C	C	C	C	C	C	C	C	-
Q	0	450	C	SL	Sev	Sev	Sev	VSev	-	-	-	-
Q	200	450	C	C	C	C	C	C	C	C	C	C
Q	400	450	C	C	C	C	C	C	C	C	C	-



EXAMPLE II

A series of tests were run to demonstrate that the addition of the polyalkylene glycol to the extrudable film compositions does not adversely effect the physical properties of the extruded film to any substantial degree. Film made from one polymer, Polymer G, was evaluated in this series of tests. The film (1.5 mil thick) was made as disclosed above in Example I, in a tubular extruder operating at 330°F. with an adaptor temperature of 330°F.

10           Table II below discloses the adjuvants added to Polymer G in parts per million (ppm) to form the various formulations that were evaluated, and it also discloses various physical properties of the formulations and of the film made therefrom. The data indicates that film made from formulations II-2, II-3 and II-4 which contained PEG (4000 molecular weight) did not suffer any significant loss of physical properties, as compared to film made from formulation II-1 which did not contain PEG, but was otherwise the same, in terms of composition, as the other formulations. The films of formulations II-2, II-3, and  
20   II-4 showed a substantial improvement in gel streaking properties over those of the control, II-1.

TABLE II

## PEG in Polymer G

Experiment	II-1	II-2	II-3	II-4
Adjuvant, ppm				
Superfloss				
BHT	800	800	800	800
Oleamide	100	100	100	100
Stearamide	500	500	500	500
PEG	200	200	200	200
	0	100	200	400
Melt Index of formulation	1.40	1.41	1.41	1.41
Density of formulation	.9223	.9223	.9223	.9223
Film Properties				
Haze, %	5.9	5.7	5.9	6.0
Gloss, 60°	136	136	137	136
GOF, 5 Min	.30	.29	.43	.38
30 Min	.10	.12	.21	.18
24 Hrs.	.08	.11	.12	.14
Treatment, dynes				
7 watts/inch	35	36	35	35
14 watts/inch	37	37	36	36
21 watts/inch	38	38	37	37
Blocking, initial (visual)	slight	slight	moderate	moderate
Blocking, induced, gms.	200	190	170	160
Minimum Fusion Temp., °F.	305	320	325	335
Ink Adhesion (Scotch Tape)	Excellent	Excellent	Excellent	Excellent
Gel streaking appearance after 60 minutes	moderate	clear	clear	clear

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EXAMPLE III

A series of tests were run as in Example II using film made from Polymer C based formulations. The film (1.5 mil thick) was made as disclosed in Example I in a tubular extruder operating at 330°F. with an adaptor temperature of 330°F.

Table III below discloses the adjuvant added to polymer C, in parts per million (ppm), to form the various formulations that were evaluated, and it also discloses various physical properties of the formulations and of the film made therefrom.

10 The data indicates that film made from formulations III-2 to III-6, which contained PEG (4000 molecular weight) did not suffer any significant loss of physical properties, as compared to film made from formulation III-1 which did not contain PEG, but which was other-wise the same, in terms of composition, as the other formulations. Film made with formulation III-2, which contained anti-oxidant, exhibited very severe gel streaking as compared to control film III-1. The use of PEG in films III-3 to III-6 substantially improved the gel streaking problem for the compositions containing anti-oxidant.

TABLE III  
PEG in Polymer C

Experiment	III-1	III-2	III-3	III-4	III-5	III-6
Adjuvant, ppm						
Superfloss	15000	15000	15000	15000	15000	15000
BHT	0	100	100	100	100	100
Stearamide	200	200	200	200	200	200
PEG-4000	0	0	200	400	700	1000
Melt Index of formulation	4.43	4.28	4.44	4.34	4.49	4.38
Density of formulation	.9215	.9215	.9218	.9216	.9218	.9218
Film Properties						
Haze, %	16.1	15.5	15.7	15.7	14.9	15.3
Gloss, 60°	68	71	66	69	72	70
COP, 5 min.	.59	.56	.62	.59	.56	.50
30 min.	.53	.51	.60	.55	.51	.56
24 Hrs.	.36	.39	.49	.51	.54	.55
Treatment, dynes						
7 watts/inch	36	35	36	35	36	36
14 watts/inch	37	38	37	37	38	38
21 watts/inch	38	39	38	38	39	39
Blocking, initial (Visual)	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Blocking, induced, gms	15	30	10	10	10	10
Minimum Fusion Temp., °F.	290	295	305	315	320	--
Tak Adhesion (Scotch tape)	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Gel streaking appearance after 60 minutes	clear	very severe	slight	clear	clear	clear

EXAMPLE IV

A series of tests were run as in Example I using film made from Polymer C based formulations. The film (1.5 mil thick) was made as disclosed in Example I in a tubular extruder operating at 330°F. with an adaptor temperature of 330°F.

Table IV below discloses the adjuvants added to polymer C in parts per million (ppm) to form the various formulations that were evaluated. The polyalkylene glycols ~~evaluated~~ in this series of tests were two solid polyethylene glycols of 4000 (PEG-4000) and 6000 (PEG-6000) molecular weight, and a liquid monobutyl ether of polypropylene glycol of 900 (PPG-900) molecular weight. The Table also discloses the gel streaking properties of the tested films at various periods of time, in minutes, after the films were extruded. The data shows that the use of the polyalkylene glycol additives substantially improves the gel streaking properties of the films treated therewith.

TABLE IV

Effect of Various Polyalkylene Glycols on Gel Streaking

	Additives, ppm*			Gel Streaking Appearance						
	<u>PEG-4000</u>	<u>PEG-6000</u>	<u>PPG-900</u>	<u>5</u>	<u>10</u>	<u>20</u>	<u>30</u>	<u>40</u>	<u>50</u>	<u>60</u>
(control)	--	--	--	C	S1	SEV	-	-	-	-
Sample no. IV-1	300	--	--	C	C	C	C	C	C	C
Sample no. IV-2	--	300	--	C	C	C	C	C	C	C
Sample no. IV-3	--	--	300	C	C	C	C	C	C	C
Sample no. IV-4	--	--	900	C	C	C	C	C	C	C

\*All the samples and the control contain 100 ppm BHT and 3000 ppm Superfloss.

The rating scheme for gel streaking: C (Clear of streaking)  
S1 (Slight streaking)  
SEV (Severe streaking)

With respect to various of the physical properties reported in Tables II and III above, the following definitions apply:

Melt index is reported in grams per 10 minutes, as measured by ASTM D-1238-62T.

The haze of the film was measured by ASTM D-1003-61.

The gloss of the film was measured by ASTM D-523-67.

The coefficient of friction (COF) is measured by ASTM D-1894-63.

10 The value in dynes given for the electrical treatment of the film represents the minimum surface tension liquid that will adhere to the film for two seconds.

The initial blocking evaluation is made visually within two minutes after the extrusion of the film and represents the amount of blocking or sticking that occurs between super-imposed layers of the film after the film passes through the nip rolls.

20 The induced blocking evaluation of the film is made after the film has been stored at 120°F. for 24 hours under a pressure of one pound per square inch. The induced blocking measurement is conducted in accordance with ASTM D-1893-61T.

The minimum fusion test is conducted with an ASKCO\* scaler manufactured by Askco, Alvin, Texas, using a one second dwell time at 30 pounds per square inch pressure.

The ink adhsion test is conducted by applying a 6 inch x 3/4 inch strip of clear scotch tape to a surface of the film that has been printed with ink and then removing the tape to see whether the tape removes any of the ink.

\*Trade Mark or Trade Name

WHAT IS CLAIMED IS:

1. In a process for extruding a film forming polyolefin based composition, which composition comprises anti-oxidant and film grade polyolefin and which is susceptible to gel streaking during the formation of said film, the improvement comprising admixing with said composition 0.01 to 0.05 per cent by weight, based on the weight of said polyolefin, of polyalkylene glycol, said polyalkylene glycol having a molecular weight of about 900 to 6000, and then extruding the resulting composition in the form of film.
2. A process as in claim 1 in which said polyolefin is an ethylene polymer.
3. A process as in claim 2 in which said polyolefin is a homopolymer of ethylene.
4. An extruded film essentially devoid of gel streaking and comprising polyolefin, anti-oxidant and 0.01 to 0.05 per cent by weight, based on the weight of said polyolefin, of polyethylene glycol, said polyethylene glycol having a molecular weight of about 900 to 6000, and said film having been made by the process of claim 1.
5. An extruded film as in claim 4 in which said polyolefin is an ethylene polymer.
6. An extruded film as in claim 5 in which said ethylene polymer is a homopolymer of ethylene.



7. An improved process for extruding a film forming polyolefin based composition into film, which film is essentially devoid of gel streaking, which comprises

extruding, under an extrusion temperature of at least 275 to 650°F. and a throughput time for said polyolefin based composition in the extruding equipment of about 0.5 to 10 minutes, an extrudable composition which comprises,

film grade polyolefin and, based on the weight of said film grade polyolefin, 0.005 to 0.1 per cent by weight of anti-oxidant for said film grade polyolefin, and 0.01 to 0.05 per cent by weight of polyalkylene glycol,

said polyalkylene glycol having a molecular weight of about 900 to 6000, and

the anti-oxidant stabilized film grade polyolefin being a material which is susceptible to gel streaking under said extrusion conditions in the absence of said polyalkylene glycol.

8. A process as in claim 1 in which said anti-oxidant is a phenol.

9. An extruded film as in claim 4 in which said anti-oxidant is a phenol.

10. A process as in claim 7 in which said anti-oxidant is a phenol.

